VI. External Validation of Proxy Cost Models

In our February 13, 1997 paper responding to the FCC staff's analysis of proxy models, we discussed the appropriate interpretation of forward-looking economic costs, whether a single proxy model can be used for multiple purposes, and the validation of proxy models.[26] We concluded the following:

Forward-looking economic costs

- The appropriate interpretation of what constitutes forward-looking economic costs is the expected costs of an actual market participant.
- The common, but incorrect, "blank slate" interpretation of the efficient entrant represents an unattainable static ideal, rather than the achievable performance of an efficient incumbent or entrant.

Use of proxy models for multiple objectives

- Proxy models may be useful for determining relative cost relationships between high-cost and low-cost areas for purposes of targeting a given universal service fund, but are currently not suitable for determining price levels for unbundled network elements or access services.
- The FCC's inclusion of allocated joint and common costs in economic costs results in a fully distributed cost model that dictates prices. As markets become more competitive, prices will increasingly be determined by market forces, regardless of what is determined by cost models.

Model Validation

- The standardization of input values may bring the statewide average results of the proxy models closer together, but does not indicate how well the models relate to the costs of a dynamically efficient actual firm.
- ARMIS, or similar suitable data provides a good starting point for expenses. The validation of network investments requires an engineering assessment of the network design produced by the models.
- More needs to be done to ensure the accuracy of network designs below statewide aggregates, particularly in lower-density serving areas.

[26] "Appropriate Standards for Cost Models and Methodologies."

We believe these conclusions are relevant in the current exercise of proxy model evaluation. In particular, we believe it is important that the models be evaluated with respect to some independent assessment of economic costs of an actual market participant. The validity of proxy models cannot be determined by simply comparing and adjusting proxy model results without a Benchmark from the real world. An engineering assessment of network design is required, as well as an evaluation of what the expected economic costs of an actual market participant would be. This applies not only to proxy models when used to determine levels of total cost, but also when models are used to determine relative cost relationships among areas.

An engineering evaluation of the current versions of the proxy models, BCPM and HM3.1, has been recently performed by Price Technical Services, Inc. and Austin Communications Education Services, Inc. (Price/Austin). Regarding the BCPM, the Price/Austin evaluation concluded that the BCPM satisfies substantially all the requirements of the Joint Board and that the flexibility of the model allows changes to reflect input values the FCC and the Joint Board believe to be appropriate.[27] Among other factors, the Price/Austin analysis concluded that:

- BCPM values for structure sharing are reasonable and appropriate in most instances (pp. 7-9);
- the mix of aerial, buried and underground plant is reasonable (p. 9); and
- loop lengths are reasonable and satisfy voice-grade transmission standards (p. 13).

[27] "Engineering Evaluation of Cost Proxy Models For Determining Universal Service Support: Benchmark Cost Proxy Model," Price Technical Services, Inc., and Austin Communications Education Services, Inc., February 23, 1997, p. 19.

Regarding HM3.1, the Price/Austin evaluation concluded that while HM3.1 is an improvement over HM2.2.2, there are several outstanding problems and shortcomings that preclude the use of the HM3.0/3.1 in any real world design or cost analysis.[28] Among the factors, the Price/Austin analysis concluded that:

- HM3.1 structure sharing is even more unrealistic than that found in HM2.2.2 (p. 12);
- cable costs are understated and are not well documented (p. 18);
- fill factors for feeder cable are too high (p. 21); and
- loop design violates industry engineering rules, including those of one of the model's sponsors (pp. 21-28).

VII. Conclusion

Significant differences still exist between the current versions of the proxy models, BCPM and HM3.1. Switching investment and structure sharing assumptions account for the majority of the difference in investment between the two models, and for 34 percent of the difference in overall annual costs between BCPM and HM3.1. Capital charge factors and expense loadings account for one-half of the difference in the annual (and monthly) costs between the models. Differences relating to the cost of capital and depreciation account for 28 percent of the difference, and annual expense and overhead loadings account for 22 percent of the difference. Therefore, on average, all of these factors combine to

[28] "Engineering Evaluation of Cost Proxy Models For Determining Universal Service Support: Hatfield Model Version 3.0/3.1," Price Technical Services, Inc., and Austin Communications Education Services, Inc., March 17, 1997, p. 38.

explain 85 percent of the difference in annual costs between the two models.

Significant differences still exist in engineering between the two models, particularly as it relates to assumptions regarding the design of loops. The Price/Austin engineering assessment has determined that BCPM is closer to satisfying the FCC and Joint board standards.

Appendix A

Switching Costs

As discussed in the text, switching costs have increased substantially for BCPM relative to BCM2. This is due to a new switch curve estimated for BCPM, based on data obtained from a survey of LECs.[29] Table A.1 below shows the switching costs for various size switches that were estimated from the switching cost equations for BCM2, BCPM and HM3.1. BCM2 switching costs were composed of a fixed cost, based on switch size, plus an incremental cost per line. BCPM and HM3.1 costs were all stated on a per-line basis.

Table A.1
Proxy Model Switch Costs

		BCM2			**BCPM**		**HM3.1**
Switch Size	BCM2 Fixed	BCM2 Incr Per Line	BCM2 Total	BCPM Incr Per Line	BCPM Total	HM3.1 Incr Per Line	HM3.1 Total
2,500	$400,000	$100	$625,000	$329.75	$915,968	$125.98	$349,943
5,000	$400,000	$100	$850,000	$277.37	$1,540,968	$115.64	$642,425
10,000	$400,000	$100	$1,300,000	$251.19	$2,790,968	$105.29	$1,169,926
60,000	$600,000	$100	$6,000,000	$229.36	$15,290,968	$78.56	$5,237,111
100,000	$900,000	$100	$9,900,000	$227.62	$25,290,968	$70.93	$7,881,570
500,000	$1,500,000	$100	$46,500,00	$225.52	$125,290,968	$46.92	$26,065,608

Notes:
BCPM formula: 225 + 261871 / Switch Line Size
HM3.1 formula: 242.73 - 14.922ln(Switch Line Size)

[29] See "Benchmark Cost Proxy Model Methodology," p. 16.

Table A.2 states total switch costs as an average per line. The tables indicate that switching costs are significantly greater for BCPM than either BCM2 or HM3.1.

Table A.2
Average Switching Costs Per Line

Size	BCM2	BCPM	HM3.1
2,500	$250.00	$366.39	$139.98
5,000	$170.00	$308.19	$128.48
10,000	$130.00	$279.10	$116.99
60,000	$100.00	$254.85	$87.29
100,000	$99.00	$252.91	$78.82
500,000	$93.00	$250.58	$52.13

Appendix B

Comparison of Loop Length Data

The following table shows the total length of loops deployed by each of the cost proxy models we have analyzed. Both the BCPM and the BCM2 report the total length of plant in their reports. HM2.2.2 total lengths can be taken from the workfile that is created for each state. HM3.1 also reports the feeder and distribution lengths in the workfile and also reports these lengths on the 'Investment Input' page of the expense modules.

Table B.1
Total Length of Loop Plant
(in thousands)

	AR	CA	TX	UT	WA	Avg
BCPM	30,795,142	293,717,541	194,516,936	18,838,870	58,870,631	119,347,824
BCM2	32,319,836	246,953,339	174,489,922	15,092,643	50,064,336	103,784,015
HM3.1	**425,269**	**1,508,557**	**1,680,756**	**184,219**	**470,933**	**853,947**
HM2.2.2*	12,995,004	129,649,521	81,899,033	12,192,044	19,341,955	51,215,511

However, these figures are not comparable because HM3.1 does not report distribution lengths on a per-line basis and, therefore, calculation of average loop lengths are not possible with the HM3.1's output. This capability was previously available in HM2.2.2.

Appendix C

Impact of DLC and Pole Cost Assumptions on BCPM and HM3.1 Costs

The following table shows the asset classes that comprise more than 5% of total assets in the Hatfield Model investment output. The numbers show the total investment for the sum of Arkansas, California, Texas, Utah, and Washington.

Table C.1

Asset Class	Total Investment	% of Total Assets
distribution cable buried	4,918,743,552	12%
distribution buried placement	4,814,702,235	12%
DLC inv w/site	4,789,296,120	12%
end office switching	3,740,515,401	9%
distribution cable aerial	2,512,556,578	6%
fiber feeder, underground	2,288,937,107	6%

Because of the complex calculations for structures costs and the different density zones in each model, we ruled out trying to substitute BCPM cable costs into the HM3.1. Since switching investment is dependent on a switch cost curve developed from a statistical sample of switch costs, it would be inappropriate to modify the function in any way. After ruling out cable cost and switching cost changes, the DLC cost is the only remaining asset class that makes up a significant proportion of total assets.

A comparison of DLC costs between the Hatfield Model and the BCPM shows that there is a significant difference in the costs assumed. The following table shows the DLC costs for each model.

Table C.2

DLC Cost					
BCPM			HM3.1		
Size	Fixed	Incremental Per Line	Size	Fixed	Incremental Per Line
48	$ 38,867	$ 92.81	96	$ 15,500	$ 77.50
120	$ 53,577	$ 92.81	192	$ 26,500	$ 77.50
240	$ 84,976	$ 92.81			
672	$ 92,147	$ 92.81	672	$ 69,000	$ 77.50
1334	$ 125,121	$ 92.81	1334	$ 87,000	$ 77.50
2016	$ 217,268	$ 92.81	2016	$ 105,000	$ 77.50

BCPM average costs are nearly twice as high as the HM3.1 costs. Commenting on the justification of input prices is outside the scope of this paper, so we refer the reader to Dr. Robert F. Austin's engineering evaluations of the Hatfield Model and BCPM.[30]

In the effort to substitute the DLC costs of the BCPM into the HM3.1, we were forced to make the sizes conform. We first made the assumption that the Advanced Fiber Communication's DLCs are the most commonly used DLCs for smaller sizes. We then substituted the costs for the 120 line and 240 line DLCs from the BCPM into the HM3.1. The 96 line DLC size in the HM3.1 was changed to 120 lines. We also changed the line card costs to conform with the BCPM.

Changing the costs of the larger size DLCs (672 to 2016 lines) was a bit more complicated. The BCPM developers relied on a statistical sample of operating LECs to estimate the costs of each size. The Hatfield Model developers attempted to cost out a single DLC: cabinet, modules, and line cards. We

[30] The Austin analysis concludes that the Hatfield model understates DLC costs. See "Engineering Evaluation of Cost Proxy Models for Determining Universal Service Support: Hatfield Model Version 3.0/3.1," Price Technical Services, Inc., and Austin Communications Education Services, Inc, March 17, 1997, pp. 27-28.

substituted the base cost of the 672 line DLC from the BCPM into the Hatfield Model. Since there was not a linear relationship for the additional 672 line increments, we divided the cost difference between the 2016 line and 672 line DLCs by two, so that each additional 672 line increment cost $62,560. This overstates the cost of the 1344 line DLC.

We also changed pole costs. The sum of distribution and feeder pole investment is equal to 5% of total investment in four of the five states we analyzed. We split the BCPM default pole cost of $450 up into $200 materials and $250 labor.[31]

The following tables shows the impact of standardizing these input costs on loop investment after standardizing for structure sharing. Table C.3 illustrates the impact on HM3.1 monthly cost per line and Table C.4 illustrates the impact on per-line investment.

Table C.3

Difference in BCPM and HM3.1 in Monthly Cost Per Line Due to Structure Sharing Assumptions and DLC and Pole Costs

	AR	CA	TX	UT	WA	Wtd Avg
HM3.1 Default	$ 32.75	$ 16.65	$ 22.08	$ 24.55	$ 20.86	$ 19.35
HM3.1 w/struc=100%	$ 38.03	$ 19.06	$ 25.26	$ 28.06	$ 23.83	$ 22.16
HM3.1 w/struc=100%, DLC	$ 40.64	$ 20.34	$ 27.05	$ 29.68	$ 25.50	$ 23.68

[31] Since the labor adjustment factor in the HM3.1 is set to 1, breaking up the cost will have no effect on the model.

Table C.4

Difference in BCPM and HM3.1 Loop Investment Per Line Due to Structure Sharing Assumptions and DLC and Pole Costs

	AR	CA	TX	UT	WA	Avg
BCPM Default	$2,079	$725	$1,142	$1,151	$1,104	$939
HM3.1 Default	$1,290	$657	$836	$909	$816	$751
BCPM 100% Structures	$2,206	$755	$1,199	$1,207	$1,159	$983
HM3.1 100% Structures	$1,581	$779	$994	$1,083	$970	$893
HM3.1 100% Structures, DLC/Pole	$1,725	$843	$1,083	$1,163	$1,056	$970
Differences						
Default HM3.1- BCPM	$(789)	$(67)	$(306)	$(243)	$(288)	$(188)
HM3.1 100% - BCPM 100%	$(626)	$23	$(205)	$(124)	$(189)	$(90)
HM3.1 100,DLC/Pole - BCPM 100%	$(482)	$88	$(116)	$(44)	$(103)	$(13)
Loop Gap Due to Structure	$(163)	$(91)	$(101)	$(118)	$(99)	$(98)
Loop Gap Due to DLC/Pole Costs	$(144)	$(65)	$(89)	$(80)	$(86)	$(77)
Total Investment Difference	$(701)	$(190)	$(389)	$(278)	$(364)	$(286)
% Due to Structure Sharing	23%	48%	26%	43%	27%	34%
% Due to DLC/Pole Costs	21%	34%	23%	29%	24%	27%

Appendix D

Annual Charge Factors

Both BCPM and HM3.1 have opened up the development of annual capital charge factors (ACCFs) relative to earlier versions of the models.

HM3.1 develops its default ACCFs using calculations which assume straight line depreciation and zero net salvage value of investments. According to the HM3.13 documentation, the developers have taken net salvage into account by adjusting the economic lives ("adjusted projection lives") associated with the investments modeled in HM3.1. However, the HM3.1's unadjusted lives, net salvage factors, and adjustment algorithm are all outside the model and are undocumented. Although the HM3.1's capital cost worksheet can be used as a "black box" to estimate the adjusted life given detailed input data, the reverse is not possible. It appears that the HM3.1 uses values consistent with FCC prescriptions,[32] but it is not possible to verify this directly. The HM3.1 could be improved significantly by bringing these calculations into the model. Apart from the adjusted projection lives, user-adjustable inputs which affect capital charge factors are the cost of debt, cost of equity, percentage of debt in the financing mix, and a tax rate meant to capture taxation at both the federal and state levels. HM3.1

[32] See Richard B. Lee, "Selection of Plant Lives For Use in Forward-Looking Economic Cost Calculations."

develops a table of ACCFs by projection life (in whole years) and employs a table lookup function to assign factors to its investment accounts.

BCPM develops its ACCFs in a multi-worksheet module which is separate from the rest of the model's network engineering, investment costing and reporting logic. The BCPM capital cost module is a very flexible tool with user adjustable parameters which allow the model's capital costing assumptions to be altered at a fundamental level. The user may set the economic and tax (accelerated cost recovery) life of each investment account used by the model, net salvage factors by investment account, the shape of survival curves (and therefore depreciation schedules), as well as other financial parameters. Federal and state tax rates are separate inputs of the model, though the model does not reflect state-by-state variation in rates. The BCPM is superior to HM3.1 in the openness and flexibility of its capital calculations. This allows the modeling of capital cost scenarios that differ fundamentally from the default scenario. As a result, it is possible to set the structure of the BCPM calculations to match the HM3.1 methodology in most ways. In contrast implementing BCPM methodology in HM3.1 is a matter of tuning input values to get a local match of output values.

To determine the effect of the models' capital costing assumptions on cost outputs, we conducted two experiments. First, we determined the approximate adjusted projection lives for use in HM3.1 which capture the effect of the BCPM's economic lives, net salvage factors, nonlinear depreciation schedules and ACRS tax calculations in a way conformable to HM3.1. Second, as a consistency check, we also determined the ACCFs which would obtain with the BCPM's book depreciation switched to a straight line method. Other user parameters were appropriately harmonized (see Tables D.1 and D.2).

Table D.1
Changes to HM3.1 capital cost worksheet to implement BCPM default ACCFs
User inputs

Parameter	**HM3.1 Default**	**BCPM equivalent value**
Cost of debt	7.7%	7.8%
Cost of equity	11.9%	13.1%
Discount rate	10.01% (weighted avg. cost of capital)	11.39% (does not match BCPM default value since it is not user adjustable)
Debt ratio	45%	32.8%
Federal tax rate	39.25%	37.26% (combines Federal and state tax rates to produce equivalent rate of return gross-up)
State tax rate	0%	0%
Adjusted projection life (see Table D.3)	Varies by account	Varies by account
Tax life	Identical to book life	Effect of ACRS incorporated in adjusted projection life
Future net salvage	Incorporated in adjusted projection life	Incorporated in adjusted projection life
Survival curve	Assumes straight-line depreciation	Incorporated in adjusted projection life

Calculated values

Weighted average cost of capital	10.01%	11.39%
Grossed-up rate of return (equals ACCF for Land account)	14.24%	16.63%

Table D.2
Changes to BCPM capital cost module to implement HM3.1-style ACCF method

User inputs

Parameter	BCPM Default	HM3.1 equivalent value
Cost of debt	7.8%	7.7%
Cost of equity	13.1%	11.9%
Discount rate	7.8%	10.01% (weighted avg. cost of capital)
Debt ratio	32.8%	45%
Federal tax rate	35%	39.25% (in HM3.1, federal and state taxes are combined in a single factor)
State tax rate	5.3%	0%
Economic life (see Table D.3)	Varies by account	HM3.1 adjusted projection life
Tax life	Varies by account	Set to ACRS life closest to economic life
Future net salvage (see Table D.3)	Varies by account	0% (HM3.1 incorporates net salvage in adjusted projection life)
Survival curve	CG&S (except Land account)	Square Life (all accounts)

Calculated values

Weighted average cost of capital	11.39%	10.01%
Grossed-up rate of return (equals ACCF for Land account)	16.63%	14.24%

The main challenge in implementing BCPM parameter values in HM3.1 is the HM3.1's external adjustment of asset lives for net salvage. Because of this, it is not appropriate to supply the BCPM asset lives as inputs for HM3.1 – to do so would be to assume zero net salvage.[33] The resulting adjusted BCPM lives are reported in Table D.3.

[33] It would be preferable to conduct an explicit adjustment of the BCPM lives for net salvage using the Hatfield algorithm. However, it is possible to use the HM3.1 to calculate asset lives which adjust for the effect of other methodological differences between the models (i.e., survival curves and ACRS) combined with net salvage. This analysis involves determining the HM3.1 adjusted projection lives consistent with the BCPM ACCFs once the user parameters common to the models have been equalized.

Table D.3
Comparison of Adjusted and Unadjusted economic life of selected investments in HM3.1 and BCPM

	Account	(1) HM3.1 life adjusted	(2) BCPM book life	(3) BCPM net salvage	(4) BCPM life adjusted	(5) % Difference (C4-C1)/C1
2112	Motor Vehicles	9.16	8	11%	7.42	-19%
2115	Garage Work Equipment	11.47	12	3%	10.06	-12%
2116	Other Work Equipment	13.22	14	1%	12.86	-3%
2121	Buildings	48.99	42.5	3%	na (see text)	na
2122	Furniture	16.56	16	3%	12.69	-23%
2123.1	Office Support Equipment	11.25	11	2%	10.66	-5%
2124	Computers	6.24	5.5	3%	5.35	-14%
2212	Digital Switching	16.54	10	2%	8.47	-49%
2232.2	Digital Circuit Equipment	10.09	8.5	-1%	7.51	-26%
2411	Poles	16.13	30	-89%	11.34	-30%
2421-m	Aerial Cable - Metallic	16.8	12.5	-18%	10.14	-40%
2421-nm	Aerial Cable - Non-Metallic	22.11	19	-22%	14.46	-35%
2422-m	Underground - Metallic	21.17	11.5	-8%	11.65	-45%
2422-nm	Underground - Non-Metallic	22.87	19	-17%	15.63	-32%
2423-m	Buried - Metallic	19.86	14	-6%	13.4	-33%
2423-nm	Buried - Non-Metallic	24.13	19	-12%	16.85	-30%
2441	Conduit Systems	51.35	50	-5%	17.6	-66%

Explanation for column data
(1) From Inputs sheet of HM3.1 expense module
(2)-(3) From Account Inputs sheet of BCPM capcost.xls module
(4) Looked-up from HM3.1 capital cost worksheet (uses weighted average to determine fractional part of adjusted life).

There was one asset group, buildings, which is modeled in both BCPM and HM3.1 for which this method for determining the adjusted projection life failed. This was because the minimum of the HM3.1 ACCF schedule was above the BCPM default ACCF for buildings, a result of the different discount rate concepts in the models.[34] For the investment accounts where adjusted projection lives could

[34] Although the BCPM ACCFs are mostly higher than in HM3.1, this indicates that by discounting at the cost of debt (as opposed to the weighted average cost of capital) the BCPM overvalues the stream of capital charges and thus its ACCFs are too low, other things equal.

be modified, the BCPM's adjusted lives are markedly shorter than the HM3.1 default adjusted lives after equalizing other capital cost inputs. The effect of the differences in lives on model costs is reduced by the relative flatness of the HM3.1 ACCF schedule at long lives.

To measure the effect of the BCPM assumptions on the HM3.1 monthly cost per line, we ran a scenario ("H2") in which we added BCPM capital cost inputs to the HM3.1 default scenario ("H1"), and another ("H4") in which the capital cost inputs were added to the "H3" scenario.[35] The average monthly cost per line for the scenarios, and the absolute and percentage change in cost are reported in Tables D.4a and D.4b. The percentage increase in cost is relatively consistent across states, and slightly higher when structure sharing is set to 100 percent. Using the HM3.1 default as the base, the percentage increase in monthly average line is in the 17-18 % range. Relative to the H2 scenario, which has higher structures and DLC investment than the default, the increase is 18 percent across all states. To put these cost increases in perspective, the increase from HM3.1 to BCPM in the weighted average cost of capital is 13.8 percent, and the change in the rate of return grossed-up for federal and state taxes is 16.8 percent. The latter figure reflects capital structure and tax rate as well as cost of funds differences between the models. These factors collectively explain most of the cost difference attributable to the methodological differences in the BCPM and HM3.1's capital cost modules. The remainder is attributable to factors underlying BCPM's shorter

[35] H3 sets the structures sharing factors to 100% and sets several pole and DLC cost parameters to BCPM values. See Appendix C for details.

adjusted asset lives: book lives, survival curves, accelerated depreciation, and net salvage.

Table D4a
Effect of BCPM Capital Cost Inputs on HM3.1 Monthly Costs

Entire state

Monthly Avg. Cost/Line

State	Scenario H1	Scenario H2	Difference	% Difference
Arkansas	$32.75	$38.55	$5.80	18%
California	$16.65	$19.43	$2.79	17%
Texas	$22.08	$25.87	$3.79	17%
Utah	$24.55	$28.71	$4.17	17%
Washington	$20.86	$24.40	$3.54	17%

RBOC territory

Monthly Avg. Cost/Line

State	Scenario H1	Scenario H2	Difference	% Difference
Arkansas	$25.27	$29.56	$4.29	17%
California	$16.09	$18.75	$2.66	16%
Texas	$18.79	$21.94	$3.15	17%
Utah	$20.65	$24.07	$3.43	17%
Washington	$18.32	$21.33	$3.01	16%

Non-RBOC territory

Monthly Avg. Cost/Line

State	Scenario H1	Scenario H2	Difference	% Difference
Arkansas	$47.32	$56.06	$8.74	18%
California	$18.26	$21.42	$3.16	17%
Texas	$31.30	$36.88	$5.59	18%
Utah	$103.63	$122.85	$19.22	19%
Washington	$26.22	$30.88	$4.66	18%

Table D4b
Effect of BCPM Capital Cost Inputs on HM3.1 Monthly Costs

Entire state

Monthly Avg. Cost/Line

State	Scenario H3	Scenario H4	Difference	% Difference
Arkansas	$40.64	$48.13	$7.49	18%
California	$20.34	$23.96	$3.63	18%
Texas	$27.05	$31.95	$4.89	18%
Utah	$29.68	$35.00	$5.32	18%
Washington	$25.50	$30.07	$4.57	18%

RBOC territory

Monthly Avg. Cost/Line

State	Scenario H3	Scenario H4	Difference	% Difference
Arkansas	$31.31	$36.90	$5.59	18%
California	$19.59	$23.05	$3.47	18%
Texas	$23.01	$27.12	$4.11	18%
Utah	$24.93	$29.34	$4.41	18%
Washington	$22.32	$26.24	$3.92	18%

Non-RBOC territory

Monthly Avg. Cost/Line

State	Scenario H3	Scenario H4	Difference	% Difference
Arkansas	$58.83	$70.02	$11.19	19%
California	$22.53	$26.63	$4.10	18%
Texas	$38.37	$45.47	$7.10	18%
Utah	$125.92	$149.86	$23.94	19%
Washington	$32.20	$38.14	$5.94	18%

We also determined the effect of the HM3.1's capital costing assumption the BCPM. Thanks to the flexibility of the BCPM's inputs, it is possible to replicate the HM3.1 capital cost module in every respect except that it is not possible to eliminate the use of ACRS tax depreciation in BCPM with user inputs alone.[36] Whereas the BCPM default economic lives of assets must be adjusted for input in HM3.1, the HM3.1 default projection lives can be used in BCPM provided that the

[36] We determined that with the ACRS tax tables modified to match the HM3.1 book depreciation, BCPM can be made to generate ACCFs effectively identical to HM3.1.

accompanying future net salvage factors are set to zero. To more closely match the HM3.1 use of straight-line depreciation for tax purposes, we chose ACRS tax lives close to the adjusted projection lives, noting that this will in some cases be contrary to federal tax law. Under these assumptions, monthly average cost per line drops 11-12% for the territories we studied; excluding the $11.34 per line operating expenses, monthly costs drop in by 17 to 18 percent (see Table D.5).

Table D.5
Uncapped Average Cost Per Line
BCPM Default versus BCPM with Hatfield 3.1 capital cost parameters

Geographical Unit	BCPM Default	BCPM with HM3.1 Capital Cost Inputs	Difference	% Difference	% Difference (excludes line loaded expenses)
United States	$35.73	$31.45	-$4.28	-12%	-18%
Arkansas	$53.00	$45.99	-$7.01	-13%	-17%
Arkansas (BOC)	$43.63	$38.11	-$5.52	-13%	-17%
California	$28.86	$25.66	-$3.20	-11%	-18%
California (BOC)	$28.09	$25.02	-$3.07	-11%	-18%
Texas	$36.63	$32.22	-$4.41	-12%	-17%
Texas (BOC)	$32.22	$28.51	-$3.71	-12%	-18%
Utah	$37.48	$32.95	-$4.53	-12%	-17%
Utah (BOC)	$33.69	$29.75	-$3.94	-12%	-18%
Washington	$35.78	$31.51	-$4.28	-12%	-18%
Washington (BOC)	$31.03	$27.51	-$3.53	-11%	-18%

The smaller percentage change in total monthly line cost in BCPM versus HM3.1 reflects the fact that some expense and overhead cost elements are sensitive to the ACCFs in HM3.1 but not BCPM. Considering only the BCPM's investment-driven costs, the percentage cost changes from substituting the other model's capital cost inputs are basically symmetrical.

There are some additional computational differences between and shortcuts employed by both BCPM and HM3.1 which can have measurable effects on the

ACCFs, if not quite as dramatic as the tax-adjusted cost of funds. Both models report "levelized" ACCFs so the effect of nonlinear book and/or tax depreciation schedules is spread over the economic life of the asset. BCPM accomplished this by dividing the NPV of capital charges by an NPV factor determined by the economic life of the asset and the discount rate. For these purposes, the BCPM's use of the cost of debt (7.8% default) as its default discount rate is in error as it overvalues the stream of capital charges given the cost of capital and capital structure. Indeed, without tracing the calculations dependent on the discount rate, an observer would have no reason to expect that a rate other than the weighted average cost of capital (11.39%) would be used in this context. The BCPM should, like the HM3.1, use the weighted average cost of capital to value the stream of charges. HM3.1 levelizes its charges by using the Microsoft Excel PMT function to calculate the annual payments over the adjusted life of the asset from an annuity valued at the NPV of charges. Since HM3.1 develops a generic schedule of ACCFs for whole-year asset lives, but the investment accounts' default projection lives are expressed (in years) to two decimal places, it employs a weighted average of ACCF table lookup results to develop the asset-specific factors. HM3.1 also applies an averaging procedure of beginning-of-year and end-of-year values to provide an approximate implementation of the mid-year capital placement convention. In contrast, BCPM employs exact procedures to determine the effect of fractional lives and mid-year capital placements.

The lower capital charges in HM3.1 are amplified by its overhead allocation method. Variable overhead costs in HM3.1 are computed by network element as a fraction of annual costs which consist of annual capital charges, network expenses and miscellaneous support expenses. The annual costs excluding overhead consist mostly of the capital charges. Therefore, HM3.1's implicit overhead factor (i.e., the factor applied to investment which would generate the variable overhead amount) is proportional to the ACCFs. Holding investment levels constant, variable overhead in HM3.1 is lower using its default capital cost inputs than using BCPM-equivalent inputs. According to the HM3.13 documentation, the variable overhead allocation is meant to capture costs which "vary with the size of the firm," e.g., with the number of loops (implicitly, weighted by the amount of outside plant deployed per loop). It is made clear that the 10.4% default variable overhead factor is applied to costs, but not how costs are a better measure of firm size than investment amounts. Nor do we necessarily agree that 10.4% represents a conservative value when applied to annual cost rather than investment amounts.

In all, the differences in capital cost assumptions between BCPM and HM3.1 are almost entirely associated with lower default capital carrying charges in HM3.1 than in BCPM, holding investment equal. The effect is compounded by the variable overhead element of HM3.1 cost, which has a positive relationship to the ACCFs because they depend on the annual capital charges. The HM3.1 cost of money and debt-to-equity ratio inputs have default values unchanged from HM2.2.2 which generate an unreasonably low forward-looking cost of capital. To the extent that appropriate forward-looking asset lives should be shorter than current FCC prescriptions, the HM3.1 capital carrying charges are biased downward in this respect as well.